

## INTRODUCTION

Polyurethane foam is a popular form of thermal insulation in the construction industry. Isocyanate is one of the main ingredients used to make polyurethane plastics. Polyurethane foam is formed by mixing an organic polyol and an isocyanate along with amine or organometal catalysts and a fluorocarbon blowing agent. Rigid foams use methylene bisphenyl isocyanate (MDI) as the isocyanate component, while flexible foams commonly use toluene diisocyanate (TDI).

The main health hazard associated with this type of work is the inhalation of free MDI. If exposed to a high concentration, a direct irritant response usually appears 4-8 hours later and may also be accompanied by such symptoms as a cough, chest pain, increased fluid in the lungs, and possibly some difficulty in breathing. The other toxic response from inhalation of MDI is an allergic response possibly progressing to asthma. This does not occur on the first exposure, but requires some time for the individual to become sensitized. Once sensitized, lower exposures than normal will cause the allergic response. There also seems to be some individual variability concerning sensitization.

## ISOCYANATE-CONTAINING PRODUCTS

Polyurethanes are commonly used to manufacture flexible and rigid foams and synthetic rubbers, as well as in some paints, varnishes, lacquers, and adhesives.

Some common products used are:

- Two-part Foam (Rigid Foam)
- Castable Soft Polyurethane Elastomer (Flexible)
- Polyurethane foam sealants
- Flexible molding materials
- Urethane based paints

## POTENTIAL ROUTES OF EXPOSURE AND HEALTH EFFECTS

The routes of exposure to isocyanates are mainly through inhalation and skin exposure. Isocyanates are used in the manufacturing of plastic, and in some cases not all of the isocyanate is used up in the chemical reaction. The un-reacted isocyanate evaporates into the air and poses a potential health hazard. Isocyanate vapors can also be released into the air by some work activities such as spraying paint containing isocyanates, heating polyurethane plastics, cutting polyurethane foams using hot wire methods, and applying varnish.

Once the isocyanate-containing products are cured completely, there is no release of isocyanate vapors, unless it is heated enough to break it down into its original components.

Inhaling even small amounts of isocyanates may sensitize a person and they can develop asthma-like reactions and symptoms. Sensitization may happen within days of exposure or take months or years to develop.

It is well known that once sensitized, a person is likely to experience symptoms upon repeated exposure, even in very small concentrations. The properties of chemicals, the amount and duration of exposure, as well as unique individual factors may increase the chances of developing isocyanate-induced asthma.

Direct skin contact with isocyanate-containing products may cause rashes, blistering and reddening of the skin. Again, repeated skin contact may cause contact dermatitis and skin sensitization. Some recent research has suggested that isocyanate exposure through the skin is very significant in the development of respiratory sensitization. Therefore, skin contact should be avoided.

Exposure of isocyanates to the eye can result in eye irritation, temporary blurred vision, and cornea damage.

## OTHER CONSIDERATIONS

### Substitution

- Avoid using isocyanate-containing products as much as possible. Use other types of material as an alternative.
- Use isocyanate-free materials such as isocyanate-free paints, cement, polystyrene foam etc. Silicone and natural rubber are another type of material that may replace the use of polyurethane foam in some instances. Other materials, such as Celastic (a nitrocellulose plastic) or Geopolymer foam, may be an alternative to isocyanate products as well.
- If you have to use polyurethane products, but you have a choice between products, choose the product with the smallest isocyanate component. Check the Material Safety Data Sheet for approximate percentages. Some products contain isocyanates as high as 70-90 %.
- Minimize the use of products containing Toluene Diisocyanate (TDI). Instead use products with MDI component that has a much lower vapor pressure (a lot less volatile) than TDI.

### Training

- One of the most important components of ensuring that everyone using and working around isocyanate-containing product is protected is through education and instruction of users, including first aid attendants.
- The training session should cover signs and symptoms of isocyanate-induced illnesses, proper handling procedures, avoidance of spills, and good housekeeping practices.
- Educate to workers that following manufacturer's directions is very important to ensure to get the correct reaction to use up all the free monomers and not leave any product unreacted. After curing, the fully reacted polyurethane resin formed is no longer chemically active and is not a hazard to health, unless it is heated to the point of decomposition.

### Planning and Hazard Communication

- At the planning stage of an interior job, coordinators must ensure that the building has good general ventilation and enough space to accommodate any necessary local exhaust ventilation systems.
- Prior to conducting a large project involving isocyanate-containing product, a comprehensive safety meeting must be held to make everyone working in close proximity aware of the health and safety hazards associated with the process.
- The work area or enclosure area where isocyanate-containing products are being used should have adequate signage to warn of the hazard and what protective equipment is necessary when entering the area.

- Read the Material Safety Data Sheet for the isocyanate products being used. These MSDSs states any precautionary measures to be taken, first aid recommendations and any special handling and disposal procedures associated with the particular product. Ask the manufacturer with any questions about the products. MSDSs must be kept on site for further reference.
- Open flames, cutting and welding torches, electric heaters, high intensity lamps, lighted pipes, and cigarettes are prohibited from isocyanate storage areas and immediate work areas.
- When metal with urethane foam has to be welded or cut, strip the foam away from the affected area. A fire watch should be on standby and fire extinguishers must be readily available.
- Due to the combustible nature of polyurethane foam, the finished product must not be exposed to flames or other sources of heat.

## RESPIRATORS AND PROTECTIVE CLOTHING

### Respirators:

- While spraying or supervising spray activity, a NIOSH/MSHA-approved full face supplied air respirator must be worn. The spray action will generate high airborne concentrations of isocyanate aerosol and vapor.
- Wear a NIOSH-approved respirator with organic vapor with acid gas and dust prefilter (dust/mist or HEPA) while performing activities other than spraying, such as mixing, sanding, sawing or finishing polyurethane products.
- All wearers of respirators are fit tested and fit test record is retained.
- The respirators and cartridges/filters must be NIOSH/MHSA approved, and are selected, used and maintained in accordance with the Standard, Use and Care of Respirators.
- Respirators are stored and cleaned according to the manufacturer's instructions.

### Other Protective Clothing:

- Impervious gloves, such as butyl rubber, Viton, or Poly Vinyl Alcohol are worn at all times when isocyanate-containing products are being handled and used. Follow the manufacturer's recommendations for the type of glove.
- Everyone working with isocyanate-containing products must wear protective clothing, such as disposable coveralls.
- Eye protection such as safety goggles must be worn at all times when mixing, cutting, sanding polyurethane based products.
- All protective clothing should be removed, stored, and disposed of in a designated area, away from eating areas.

## Cleaning Procedures:

- Eye wash facilities and washing areas must be available in the work area. If you get isocyanate products on the skin, rinse the skin with diluted rubbing isopropyl alcohol to neutralize the isocyanate, and then wash thoroughly with soap and water.
- Do not use acetone or concentrated alcohol on skin as these chemicals will dry and irritate the skin.
- Everyone working with the product must be trained and instructed in how and when to use the washing facilities.
- Grossly contaminated clothing should be discarded. Clothing with small amounts of unreacted product can be neutralized with mixture of 10% isopropyl alcohol and 1% ammonia in water and sent for laundering.
- Hands must be thoroughly washed before eating or smoking.
- Leave contaminated clothing at the workplace. Do not wear contaminated clothing home since you do not want to expose other people to these chemical compounds.
- Keep work clothes, whenever possible, in separate lockers from street clothes.
- Changing areas should be separate from work areas and eating area.

## **DURING SPRAYING OF ISOCYANATE-CONTAINING PRODUCTS**

- Spray application should only be conducted by trained applicators that are familiar with its proper use and limitations.
- Always wear full face supplied air respirator if supervising spray operations.
- During Spraying, post a sign warning other people of spray operation in the area. For example, the sign can read "Isocyanate Products in Use - Do Not Enter This Area Unless Wearing Proper Respiratory Protection".

## **STORAGE AND DISPOSAL OF ISOCYANATE PRODUCTS**

### General Guidelines:

- It is important to keep general work areas clean to prevent spills. Most occupational exposures to isocyanates occur by accidental spills.
- Keep covers on containers.
- Clean up all spills immediately to minimize vapor release into work environment.
- Keep the number of isocyanate products in the shop to a minimum. Order as projects come up.
- Store in cool, dry location. Store away from any heat source and direct sunlight.
- Foam spray packs are under pressure. Avoid open flames and do not puncture or incinerate containers.
- Keep away from incompatible substances, such as bases and alcohol that can initiate uncontrollable polymerization. Isocyanates react vigorously with water and ammonia, or strong bases to produce heat and carbon dioxide gas. If this occurs in a sealed container, the container may rupture or explode, releasing isocyanate vapor and CO<sub>2</sub> in the air.
- Periodically, check the integrity of the containers and inspect for signs of increased pressure within the containers. Ensure that the integrity of the containers and seals are maintained.
- Some products may have a shelf life. Check with the manufacturer if you are not sure.
- Ensure all containers display proper labels.
- Empty, non-returnable containers which contained isocyanates, must be decontaminated by filling them with water and allowing them to stand for a minimum of

- 48 hours, without being sealed, stopped or closed. After which the containers must be pierced to prevent re-use.
- To decontaminate large drums, use 5% sodium carbonate solution. Leave them to stand for at least 24 hours, with bungs removed, to allow CO<sub>2</sub> to escape.
- To dispose of expired products or old foam kits, ask the manufacturer or the supplier for proper disposal procedures.

## EMERGENCY PROCEDURES

### First Aid

- Consult the Material Safety Data Sheet for the specific emergency procedures for the product you are using.
- If you get the isocyanate product on the skin, flush with copious amounts of water.
- If you get the isocyanate product in the eye, flush for at least 30 minutes with water.
- If your clothing becomes grossly contaminated, remove them immediately. Heavily contaminated clothing should be discarded. Otherwise, immerse in decontamination solution prior to laundering in aqueous ammonia, about 1-2 % by weight, or 5 to 10% sodium carbonate, and a heavy detergent.
- If you accidentally swallow isocyanate product, do not induce vomiting, drink water or milk to dilute material in stomach, and call poison control immediately.

### Fire

- Isocyanates and most products containing them are flammable, they will burn and release toxic gases such as carbon monoxide, nitrogen oxides, and hydrogen cyanide.
- Burning polyurethane products made with isocyanates may release benzene, toluene, carbon monoxide, nitrogen oxides, and hydrogen cyanide.
- During foaming and curing operations, foam temperatures may rise above 284°F, a condition that could result in spontaneous combustion. Therefore, it is important to consult the supplier instructions or product data sheet for recommended thickness of foam.
- Isocyanate fires should be treated as a Class C fire hazard – do not use water or foam-containing fire extinguishers to extinguish flames. Use dry chemical powder, carbon dioxide or fire fighting foam.
- The area of the fire must be evacuated immediately. The Fire Department should be notified of the nature of the fire, i.e., isocyanate product and other chemicals such as hydrogen cyanide, phosgene, and carbon monoxide in the fire.
- After the fire has been extinguished, the area should be inspected by personnel wearing protective equipment to remove any suspected isocyanate residues before unprotected workers are permitted to enter the area.

### Spills

- A written spill response plan should be developed and implemented and all workers should be trained in the procedure.
- A spill must be cleaned immediately by person wearing appropriate personal protective equipment (PPE). Evacuate anyone in the area not involved in the clean up without proper PPE. This is very important when spill occurs onto or near hot surfaces.
- Immediately cover the isocyanate spill with dry absorbent such as vermiculite or sand, do not use sawdust or shredded paper because of the fire hazard.

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- Shovel the waste into a metal container, cover and place the waste outside in a shaded dry area prior to disposal.
- Make sure that the container is not sealed so any pressure build-up can escape.
- Put containers outside, neutralize by filling them with water. Mixture should stand for 48 hrs. or until all carbon dioxide has escaped.
- If spill contaminates local sewers or water drain, inform local authorities of the spill.

### **Medical Monitoring**

- The routes of exposure to isocyanates are mainly through inhalation and skin exposure. Inhaling small amounts of isocyanates may sensitize a person and they can develop asthma-like reactions and symptoms. Direct skin contact with isocyanate-containing products may cause contact dermatitis and sensitization with symptoms such as rashes, blistering and reddening of the skin.
- Exposure of isocyanates to the eye can result in eye irritation, temporary blurred vision, and cornea damage.
- If you think you have been sensitized or have isocyanate-induced asthma, seek medical attention. Your family physician may be able to refer you to an occupational physician in the area.
- A physical exam with emphasis on respiratory system, chest x-ray, baseline spirometry should be included.
- Currently there is no specific test to find out if you will develop sensitivity to isocyanate, however, if you already have respiratory problems such as asthma, bronchitis, or emphysema you should avoid working with isocyanate containing products.
- If you have been diagnosed with isocyanate-induced illness, avoid exposure to isocyanate-containing products, before the respiratory problems become permanent.
- Persons with any history of allergies, heart problems, or respiratory difficulties should not be involved in using isocyanate products.

### **INDOOR VENTILATION FOR CONTROL OF ISOCYANATE VAPOR**

- Use general ventilation (dilution) whenever the location allows. However, general ventilation alone should not be used for controlling highly toxic chemicals.
- Fresh air or make-up air is supplied to the room to dilute the contaminant. The intake and exhaust vents should be far enough apart so that exhausted air is not brought back into the building. Also, the fresh air flow should pass through the breathing zone of workers before reaching the contaminant source.
- Ventilation systems should be inspected and maintained regularly.
- Local Exhaust Ventilation (LEV) should be used to control highly toxic substances at the source.
- Enclose the process as much as possible. Make sure that the air velocity at the source of contaminant is strong enough to capture the contaminant.
- All ducting should remain in good shape, free of holes and tears. Clean and inspect the ducts regularly since holes will reduce the effectiveness of the ventilation system. Try to minimize the number of bends in the duct as much as possible.
- When new ducts are added to an existing system, ensure that the fan is strong enough to keep sufficient air flow.

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- Make sure that an appropriate fan is chosen for the system. Factors such as air flow, flammability, explosion hazards, and noise levels should be considered.
- Ensure that air cleaners are in place as part of the system to keep contaminant from polluting the environment.
- Whenever possible, utilize a certified ventilation engineer combined with an industrial hygienist to design the system or to inspect your work.

## **Finishing Polyurethane Products**

When sanding, cutting or conducting other activities with power tools that can generate heat to finished polyurethane foam, the foam may decompose to generate toxic gases such as hydrogen cyanide. Therefore, the use of power tools should be minimized as much as possible. When finished products need to be sanded or cut, these activities should be conducted within an enclosure with adequate local ventilation.

## **RECOMMENDATIONS**

- Both indoor and outdoor sprayers should wear a supplied-air respirator with at least a half-face piece.
- Outdoor helpers and windscreen helpers should also wear a supplied-air respirator with at least a half-face piece.
- Anyone within 25' of an indoor spraying operation and 10' of an outdoor spraying operation should wear a supplied-air respirator with at least a half-face piece.
- The issue of eye protection must be addressed.
- Workers involved in the polyurethane industry must be thoroughly trained about the hazards of isocyanates and the proper precautions to be taken.

